NEW TYPES OF LINEA VENTRALIS IN COLLEMBOLA AND ITS FUNCTION

J.Rusek
Laboratory of Soil Biology, Institute of Landscape Ecology of the Czechoslovak Academy of Sciences, České Budějovice, Czechoslovakia

НОВЫЕ ТИПЫ ВЕНТРАЛЬНОЙ ЛИНИИ У НОГОХВОСТОК И ЕЕ ФУНКЦИИ

Й.Русек
Лаборатория биологии почв, Институт экологии ландшафта АН ЧССР, Ческе Будейовице, Чехословакия

All members of Collembola have ventrally in medial line of head, thorax and ventral tube a well visible morphological structure which connects the mouth of labial glands with the ventral tube. That structure was used for the denomination "linea ventralis" /9/. It is called also ventral line or ventral groove in later contributions. It was studied morphologically and histologically /1,2,12,11,5/. Step by step the connection of the labial glands with the linea ventralis /1/ and with the ventral tube /12/ was discovered. The morphology of the ventral line was described in Tomocerus flavescens /9/ and figured cross-sections through its different parts /5/. The ventral line is a tube closed on the head, it has a narrow longitudinal ventral opening on the thoracal segments and it is an opened drain in the distal part of the ventral tube. This structure of the ventral line is interrupted in the intersegmental parts of the head and thorax. This lead to the discussion about the possible secretion-conductive function of the linea ventralis. Linea ventralis was suggested not to conduct the secretion of labial glands to the ventral tube because of its opened parts which are interrupting the closed channel on the head and thorax /2/. Hoffmann /5/ has an opposite opinion pointing out the small diameter dimensions of the ventral

linea, where capilarity rules come in consideration. According to the same author, the secretion of labilal glands has sticky properties which enable the terminal vesicles of the ventral tube to adhere on the substrate.

The linea ventralis were studied recently using SEM, histochemical, and other methods to make an attempt to explain its function /10/. The SEM morphology of the ventral groove was described in eight species of Collembola, analysed the labial glands secretion as urea and came to conclusions about the fluid conductive capabilities of the ventral line.

During morphological studies of Collembola I have found some new guite different types of the linea ventralis which lead to new views on its function. One of the new types of the ventral line was partly described in the taxonomical literature in Megalothorax massoudi Deharveng, 1978, I mentioned the figures and description of the unusual linea ventralis in Megalothorax gabonensis and drew attention to a net-like linea ventralis in a new, undescribed Oncopodura species from Cuba. In the present contribution the morphology of a new type of the ventral groove in Isotomiella minor is described and its function discussed on the basis of laboratory observation.

The linea ventralis in Megalothorax minimus, Megalothorax aquaticus, Megalothorax sp. and Oncopodura sp.n. will be described in detail in taxonomical contributions.

Material and Methods

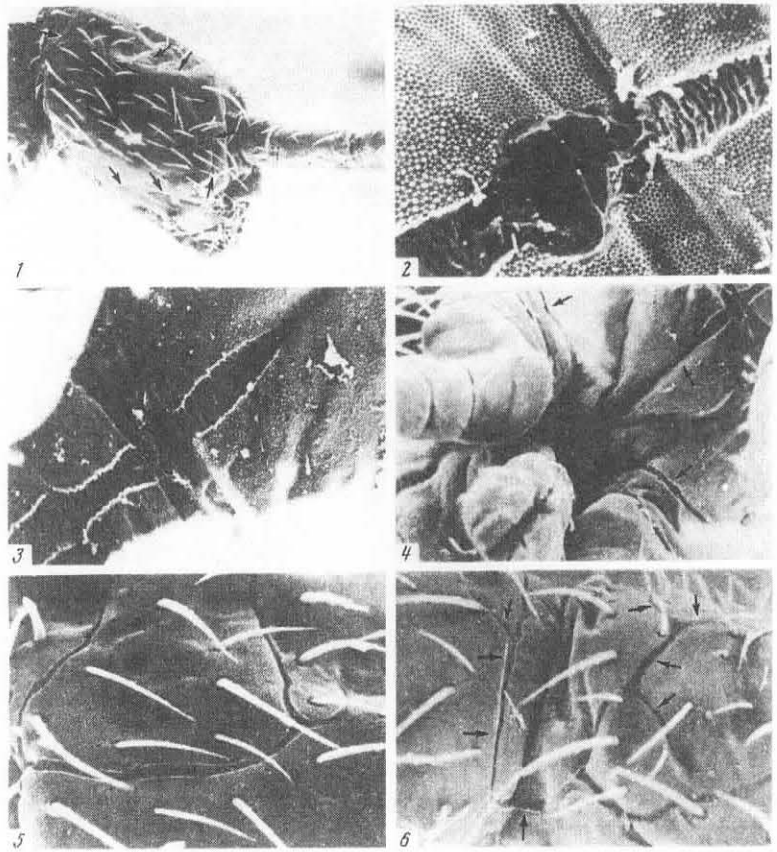
90% ethanol conserved material of Isotomiella minor (Schäffer, 1896) was mounted into slides /8/. The linea ventralis is clearly visible in fresh mounted (up to a month) slides only. The specimens for SEM were used from 90% ethanol stored material, critical point dried and coated with gold. By the same method the specimens of Megalothorax minimus Willem, 1900, Megalothorax aquaticus Stach, 1951, Megalothorax sp., Neelus murinus Folsom, 1896 and Oncopodura sp.n. were studied.

The material of Isotomiella minor for this study was collected in South Bohemia.

Description of the Linea Ventralis

The basic stem of the linea ventralis in Isotomiella minor lies ventrally in the medial line of head, thorax and the frontal face of the ventral tube. From the basal stem lateral branches run out, one pair in the hind part of the head and the second pair on the metasternum just in front of the ventral tube (Fig.1-4). The branch on the head is divided into one frontal and one posterior branchlet, reaching to the dorsal side of the heat. The metasternal pair of branches has again a large anterior metanotal and a smaller posterior branch reaching to the abdominal tergite I. and II. The branchlets of the metanotal branch reach to the mesonotum, metanotum and abdominal tergite I and are divided into smaller partly connected channels. On the abdominal tergite I and II only short channels are present, the main branches are here the anterior and the posterior ones lying parallel with the anterior and posterior borders of the tergites. The ultrastructure of the basal stem is clearly visible, the inner surface bears transversal ribs.

In Megalothorax minimus and Megalothorax aquaticus the ventral line runs also to the dorsal side of the head and the thorax. In Neelus murinus the



F i g. 1. Isotomiella minor: 1 - lateral view on head, linea ventralis (LV) indicated by arrows; 2 - LV on prosternum and mesosternum; 3 - mesosternal and metasternal part of LV; 4 - branching of ventral groove (arrows) in front of ventral tube (vt); 5 - LV on lateral part of abdominal tergite II; 6 - LV (arrows) laterally on metanotum (mt) and front of abdominal tergite I (at)

lateral branches on the meso - and metathorax run only slightly above the bases of the legs. In Oncopodura sp.n. from Cuba the ventral line makes a net of canalicules on the frontal face of the ventral tube, the lateral branches of meso - and metathorax run up to the dorsal side of the thoracal segments.

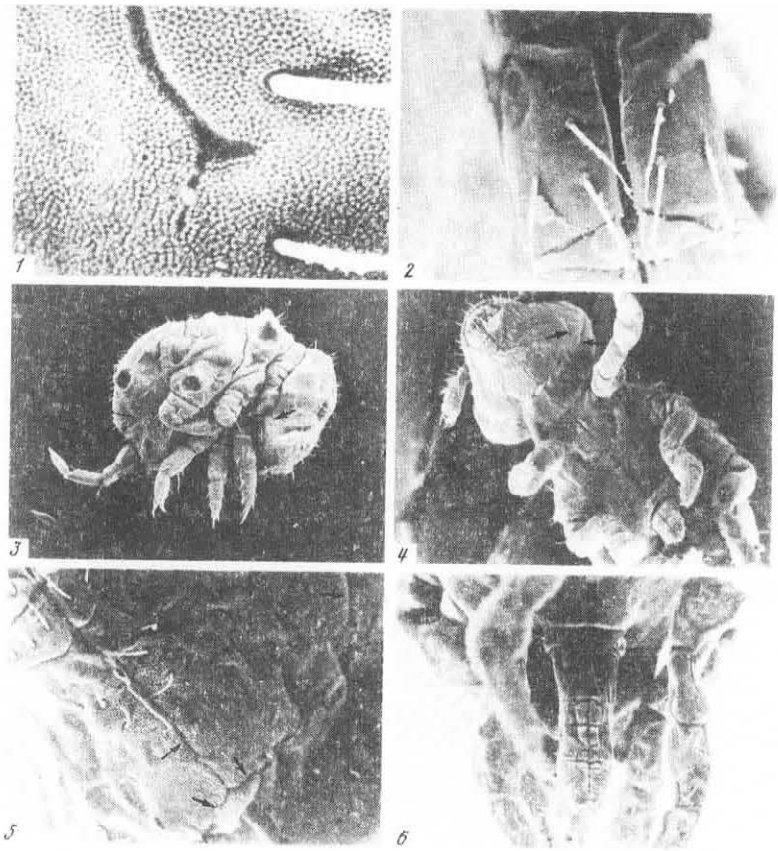


Fig. 2. Isotomiella minor: 1 – terminal part of LV branchlet on metanotum; 2 – frontal face of ventral tube with LV; Megalothorax aquaticus: 3 – lateral view on the animal (arrow indicates the lateral branch of LV on head); 4 – ventral view on the animal (lateral branches of LV on head indicated by arrows); 5 – LV (arrows) on ventral side of head; 6 – linea ventralis on frontal face of ventral tube

The Function of the Linea Ventralis

In laboratory rearings of Isotomiella minor and other species of Collembola small drops of condensed water sometimes appeared on the body of the animals. It was in the cases when the rearing containers with the animals were transferred after microscopic observation from the warmer laboratory

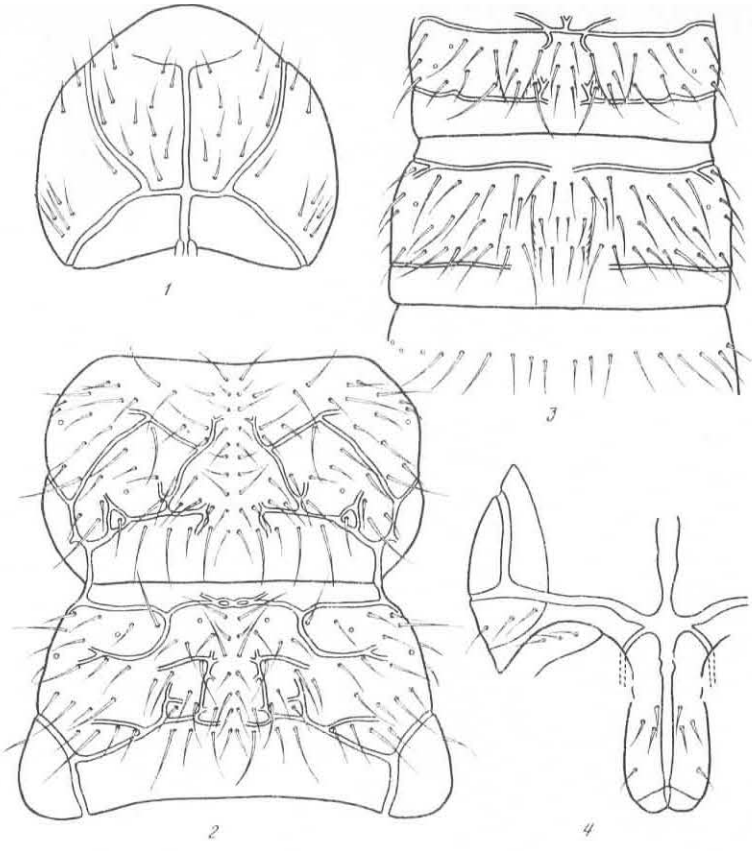
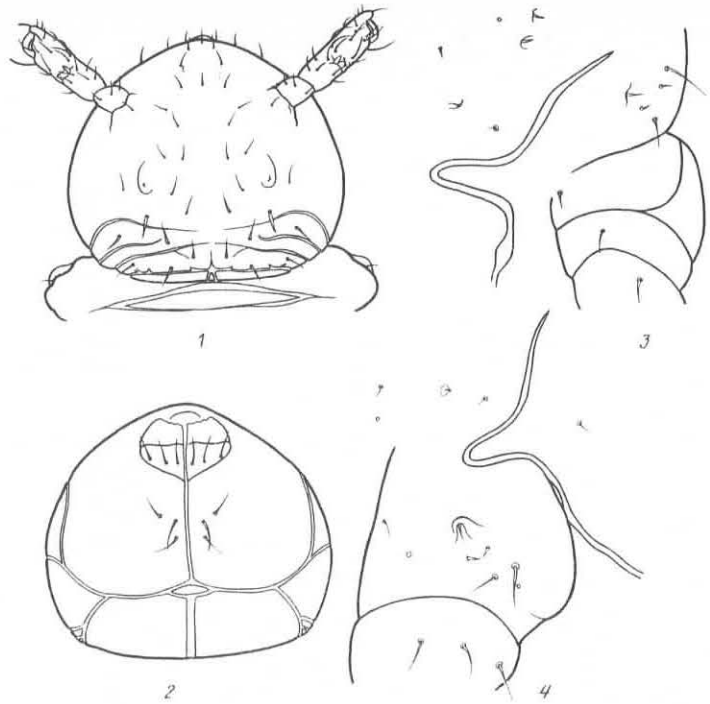


Fig. 3. Isotomiella minor: 1 – ventral branches of on head; 2 – branchlets of LV on mesonotum and metanotum; 3 – branchlets of LV on abdominal tergites I–II; 4 – branches of LV on metasternum and ventral tube

to the thermostates with low temperature (+5°C to 10°C) when the dewing point was reached. During longer microscopic observation, when the temperature in the rearing containers slowly increased, the drops of condensed water slowly disappeared from the body of the animals. The rate of disappearence of the water drops was higher in Isotomiella minor than in the species of the same length (e.g. Isotoma notabilis Schäffer, 1896, Folsomia quadrioculata (Tullberg, 1871), Pseudosinella gercynica Rusek, 1979, etc.) but without through lateral branches extended linea ventralis. In the group



F i g. 4. Megalothorax aquaticus: 1 - dorsal branchlets of LV on head; 2 - branches of LV on ventral side of head; Neelus sp.: 3 - terminal part of LV branch above base of second pair of legs; 4 - terminal part of LV branch above base of third pair of legs

of species without the extended ventral groove a pure evaporating process of water drops from the body is supposed. If only evaporation would take place in I. minor, the "disappearing" of water drops from the body should be slower and of the same rate as for example in Isotoma notabilis which does not possess a complicated system of extended linea ventralis. It seems the ventral line is a water conducting system and in the case of Isotomiella minor profitting by such a common meteorological phenomenon as the dewing point. The greatest part of water in the drops on the body surface is conducted through the channels of the linea ventralis down to the basic stem and to the water absorbing system in the ventral tube. The most complicated linea ventralis was found in depigmated adaphic species which have no degenerated furca. Lack of eyes and pigmentation are characters of euedaphic species but the presence of a well developed furca is a typical character for epigeic to hemiedaphic species of Collembola. The highly developed linea ventralis in the mentioned species must be considered as an important old phylogenetic

adaptation to the life in soils with dry periods, when the animals can compensate the water deficit only during the nights when the dewing point in the soil is reached.

Discussion

Already in the first morphological and histological studies on the linea ventralis its function was discussed. Labial glands were considered to have no connection with the ventral line /2,7,6/. Hoffmann /5/ and some other authors thought the sticky secretion of the labial glands is conducted through the linea ventralis on the terminal vesicles of the ventral tube and enables them to adhere on the surfaces used by Collembola for walking.

A detailed study brought a new light on the chemical composition of the labial glands secretion, found also in the linea ventralis, and on the possible function of the linea ventralis /10/. It was considered as a conductive system and the analogy to the water conducting system in terrestrial isopods /3/ was discussed. The water conducting function of the linea ventralis was indirectly deduced also from laboratory observations on Isotomiella minor. It can be supposed that in Collembola different adaptations for saturation of water deficiency by help of water conducting system of the linea ventralis are developed. Collembola with undivided ventral groove will saturate probably water deficiency from water drops in the environment, those with extended net-like linea ventralis and without other ecological adaptations to periodically dry environmental condition will profit by the condensed water on the body surface. Different types of water conducting systems in terrestrial isopods were described /3,4/. In them also canals filled with urine are present on some parts of the body. Different adaptations have developed in taking water from the environment in different groups of terrestrial Isopoda. The water conducting system is discussed to have probably also thermoregulating function in this group of Arthropods. In Collembola there may be also such thermoregulating adaptations in the case of Oncopodura sp.n., where the lateral brachlets on lateral sides of meso- and metonorum are expanded to shallow deepenings without any granulation.

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